A MACROINVERTEBRATE BIOTIC INTEGRITY INDEX (MBII) FOR REGIONAL ASSESSMENT OF MID-ATLANTIC HIGHLANDS STREAMS

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ABSTRACT

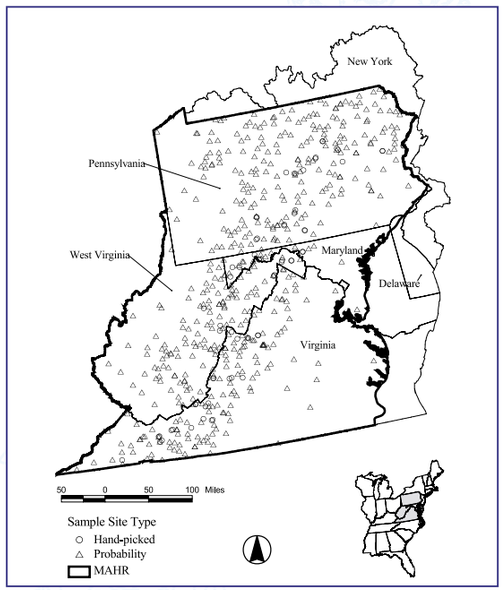
The multimetric Macroinvertebrate Biotic Integrity Index (MBII) was developed from data collected from 574 wadeable stream reaches in the Mid-Atlantic Highlands region (MAHR) by the USEPA's Environmental Monitoring and Assessment Program (EMAP) in 1993-1995. Over 100 candidate metrics were evaluated for range, precision, responsiveness to various disturbances, relationship to catchment area, and redundancy. Seven metrics were selected, representing taxa richness (Ephemeroptera richness, Plecoptera richness, Trichoptera richness), assemblage composition (percent non-insect individuals, percent 5 dominant taxa), pollution tolerance (Macroinvertebrate Tolerance Index (modified from Hilsenhoff, 1987)), and a functional feeding group (collector-filterer richness). We scored metrics and summed them, then ranked the resulting index through use of independently-evaluated reference stream reaches. Although reaches were classified into lowland and upland ecoregional groups, we did not need to develop separate scoring criteria for each ecoregional group. We found that we could use the same metrics for pools and riffles, but they were scored differently.

OBJECTIVES

- Develop a macroinvertebrate indicator of human disturbance for wadeable streams in the Mid-Atlantic Highlands.
- Examine and incorporate differences between pools and riffles.
- Assess need for classification of streams into upland and lowland ecoregions.

METHODS AND MATERIALS

Study Area and Survey Design



- EMAP probability design - 506 reaches
- 68 reaches hand-picked by USEPA Region 3 and state biologists

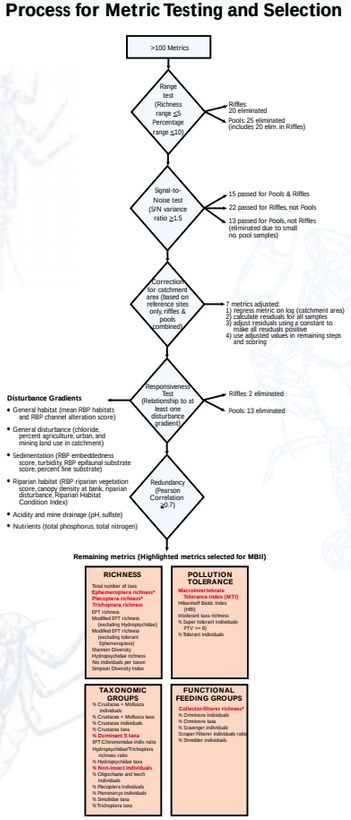
Sample Collection and Processing

- EMAP protocols
  - 11 transects along reach length of 40x wetted width
  - Macroinvertebrate sampling - 20-sec. kick nets at (595 µm) at inner 9 transects composited into riffle and pool samples
  - Quantitative and qualitative (RBP) physical habitat - entire reach
  - Water chemistry - single sample for each reach
- Land use characteristics - entire watershed (MRLC data)
- EMAP Laboratory protocols
  - Randomly selected 300 organisms from sample
  - Identification to lowest possible taxon

Data for Index Development

- Calibration data set
  - 404 probability reaches
  - 68 hand-picked reaches with quantitative physical habitat
- Validation data set
  - 102 probability reaches with quantitative physical habitat
- Data sets combined for all steps except evaluating responsiveness and setting scoring thresholds
- 34 within-year revisits used to evaluate metric and index precision.

Process for Metric Testing and Selection

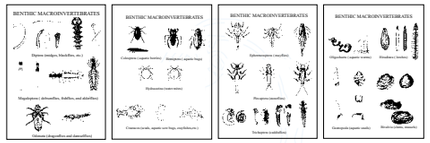


*Adjusted for catchment area

METRIC SCORING

- Single set of metrics for pools and riffles, but each habitat scored separately
- Scores for each metric on continuous scale between 0 and 10
- Maximum metric score of 10: 75th percentile among references sites
- Minimum metric score of 0: 25th percentile among impaired sites
- Metric scores summed and total multiplied by 10/7 to rescale MBII range from 0 to 100
- Ranges for pool scoring tended to be smaller and at lower values

Reference sites – ALL of the following:	Impaired sites – ANY of the following:
SO_4 < 400 µg/L	pH < 5
Acid Neutralizing Capacity > 50 µeq/L	Cl > 1000 µg/L
Cl < 100 µg/L	SO_4 > 1000 µg/L
Total P < 20 µg/L	Total P > 100 µg/L
Total N < 750 µg/L	Total N > 5000 µg/L
RBP mean habitat score > 15	RBP mean habitat score < 10
≥150 organisms	



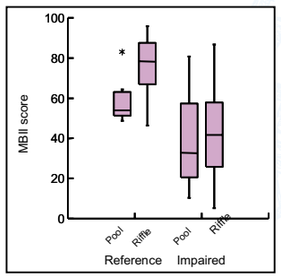
MBII SCORING AND IMPLEMENTATION

Condition categories

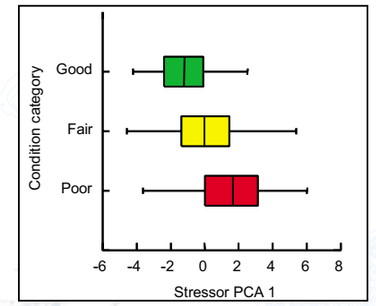
- Based on dominant habitat in a given reach (riffles or pools)
- Single set of criteria for pools and riffles
- Three sets of progressively more strict criteria applied to identify three successively smaller groups of reference reaches
- Calculated 25th percentile for each group of reference reaches and used average value (74) as the cutoff between Good and Fair
- Used 1st percentile among reference reaches as the cutoff between Fair and Poor

Evaluation of index

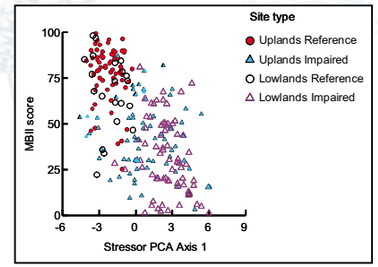
- Validation data set: 102 reaches held back to evaluate ability of index to separate reference and impaired reaches



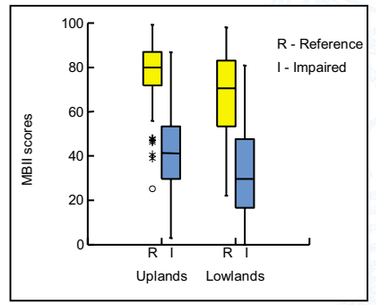
- MBII more clearly separated reference and impaired reaches in riffles than in pools
- Principle Components Analysis (PCA) on chemistry and habitat data common to all reaches



- Condition categories fell in a predictable pattern along the disturbance gradient represented by the first PCA axis.



- The MBII was correlated with the stressor PCA axis (based on dominant habitat at each site only). There was strong overlap between Uplands and Lowlands reference reaches.



- When only the dominant habitat is used, the MBII clearly distinguishes reference from impaired reaches for both the Uplands and Lowlands regions.

CONCLUSIONS

- A single set of metrics, scored differently for pools and riffles, can be used to evaluate wadeable streams in the Mid-Atlantic Highlands.
- The index is able to distinguish reference and impaired sites for both upland and lowland stream reaches.

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